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AN OPTIMISATION OF SPRAY AND PERFORMANCE EMISSION CHARACTERISTIC OF BIODIESEL AND ITS BLENDS BY VARYING INJECTION TIMING IN DIESEL ENGINE

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ABSTRACT

The main objective is to optimize the various parameters of spray for different blends of biodiesel and Injection pressure mainly with respect to Spray tip penetration Spray cone angle and Sauter Mean Diameter (SMD), using the conception of Taguchi with too categorize its involvement by Analysis of Variance normally recognized like ANOVA with the help of "Minitab 14.0" software where the optimum levels of the parameters were found using higher Signal - Noise ratio. By variying the injection timing (Normal, restarted and advanced) in the Direct injection diesel engine the performance, emission and combustion characteristics was studied. It was found KB20 at 220 bar and 19^{o} BTDC gave better performance and lower pollutant emission.

KEYWORDS: Biodiesel, Injection Timing & Spray Characteristics

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Original Article

INTRODUCTION

Most of the energy is obtained from burning the traditional fossils which are non-renewable in nature. Apart from that, recent utilisation percentage of resources could not meet the requirement in the near future and therefore sustainable use of these fuels is highly essential. In addition, combustion of such conventional fuels result in high pollutant emissions ultimately prompts environmental issues and global warming. Therefore, finding economically possible and sustainable alternative fuels has become an essential issue. Among the various fuels, biodiesel is the primarily widespread used in the educational and engineering humanity. Biodiesel fuels from animal fats, vegetable oils and waste, biological oil (drainage oil) is a clean and renewable fuel with reduced soot and emissions by advantage of its high oxygen content.

The raw materials can be varied with pure diesel to make different proportions. In spite of one's mixture preference, biodiesel will allowable lesser number of pollutants like hydrocarbons, particulates and carbon monoxide than conventional diesel, because bio-diesel burns both naturally and more inventively. Even with common diesel's compact measure of sulphur from the ultra low sulphur diesel invention, biodiesel exceed those levels since it is sulphur free.

Depending on the engine, high pressure injection pumps, pump injectors also called unit injectors and fuel

injectors. The calorific value of biodiesel fuel is about 37.27 MJ/kg. This is 9% lower than reliable amount 2 petro-diesel, difference in biodiesel force density is poorer on the standard method. At the end, these differences are less than for fossil fuel. High viscosity can point the fuel filter and injection system in engines. Vegetable oil is collected of lipids with long chains of hydrocarbons, to decrease its viscosity the lipids are bust down into lesser molecules of esters. This is done by alternative vegetable oil and living thing fats into alkyl esters using transesterification to decrease their viscosity.

TAMILVENDAN (2011) has investigate with Eucalyptus oil, distilled oil from leaf of eucalyptus as an alternate fuel for diesel fuel. Typically, Eucalyptus oil keeps low cetane number which is not suitable to resolve existing diesel engine. Conversely, this could be permissible along with diesel fuel in the form of blends. Keeping this in common, experiments have been conducted by means of blends of Eucalyptus oil and diesel fuel. SANDEEP KUMAR DURAN (2014) has done investigational study to control the combustion and performance types of direct injection diesel engine using different blends of Karanja methyl ester with diesel fuel. The Karanja biodiesel is varied with diesel in extents by volume and proposed under various loading condition in diesel engine. The combustion parameters were ecognized close to that of diesel.

YUAN GAO (2009) calculated the spray characteristics of inedible oil by investigational and simulation methods. Spray penetration, spray cone angle and spray tip speed were considered at different biodiesel ratios in a chamber with broad visualization and elevated back pressure, by a high speed video camera. The description of biodiesel spray was simulated with Star-CD software. The experimental results showed that, as the ratio of biodiesel in the blends increased, spray penetration and spray speed improved, but the spray cone angle decrease. YUNHUA ZHANG (2017) observed that biodiesel as a renewable energy is suitable more and more attractive due to the increasing scarcity of fossil fuels. For the foremost time, the development of past performance capability for the diesel engine to carry out novel linking to emissions particularly the particulate emission.

EXPERIMENTAL SETUP

Optimisation of Spray

Without considering the combustion parameters and engine design. An appropriate factor to be optimized and engine performance can be improved by relevant Taguchi technique. It is identified as of the DOE technique that for two parameters with three levels, the number of trial runs will be 9 was chosen for our work. In this present work is an attempt made to carry out an optimization analysis of Karanja oil methy lester in spray chamber by a model in groups by Taguchi technique.

Table 1: Optimisation of Spray

Level	Fuel	Injection Pressure
1	KB20	180
2	KOME	200
3	DIESEL	220

The experimental set up was shown in Figure 1 used for experimental investigation is a single cylinder, air cooled and vertical and direct injection diesel engine. Diesel engine is coupled to an eddy current dynamometer for giving maximum power of 4.4 kW engine speed of 1500 rpm. The diesel engine made up of air heater to measure temperature using an anti-pulsating drum. Smoke meter, exhaust Gas analyser and temperature indicator was used in the exhaust manifold. The fuel is measured in the burette for all load condition [5]

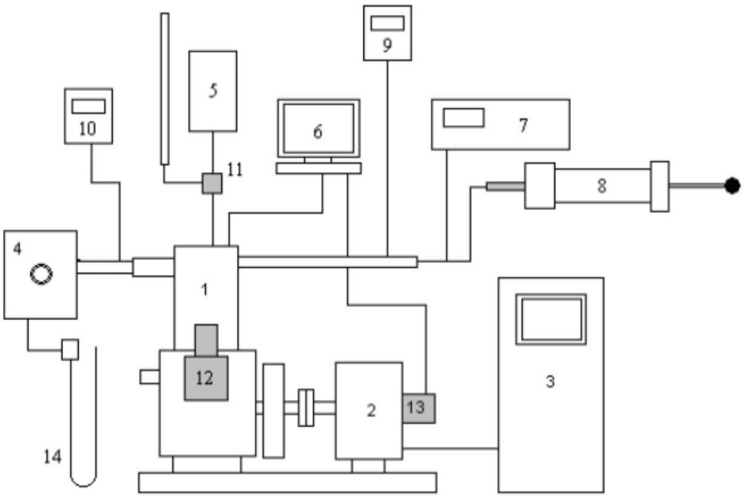

Figure 1: Experimental Layout
(1) Electrical Dynamometer (2) Diesel Engine, (3) Air Box, (4) Dynamometer Control Panel, (5) U-tube Manometer, (6) Fuel Tank, (7) Fuel Measurement, (8) Pressure Transducer, 9) TDC Position Sensor, (10) Charge Amplifier, (11) TDC Amplifier Circuit, (12) Analog to Digital Card, (13) Personal Computer, (14) AVL Smoke, (15) Exhaust Gas Analyzer [5]

RESULT AND DISCUSSIONS

It was found that the optimum parameters are blend (20%) and injection pressure (220 bar) for response parameters. The experiments are carried out at different load condition a t 1500 rpm of thee diesel engine test setup. with various injection timing 200, 23o and 27o b TDC advance, Normal and Retard injection timing for diesel and bio-diesel.

Performance, Combustion and Emission Characteristics

Brake Thermal Efficiency

The variation of brake thermal efficiency with brake power for different injection timing is presented in Figure 2. Karanja biodiesel has 10-12% additional oxygen contented than diesel fuel which help in enhanced combustion in diesel engine. Karanja oil methyl ester mark out fewer rate when it is advanced these is as of lower IMEP and calorific rate of Karanja oil methyl ester than diesel fuel. The higher brake thermal efficiency is attained when it is retarded, may be due to lower total fuel consumption and additional lubricate provided by blends. Further, among all the biodiesel blends (KB20) can be consider to the most excellent blend on top of the origin of spray characteristics and has more brake thermal efficiency Thermal efficiency of lower biodiesel blends (KB20) is generally higher. Brake thermal efficiency was highest at 19^0 bTDC 220 bar SOI timing for all load.

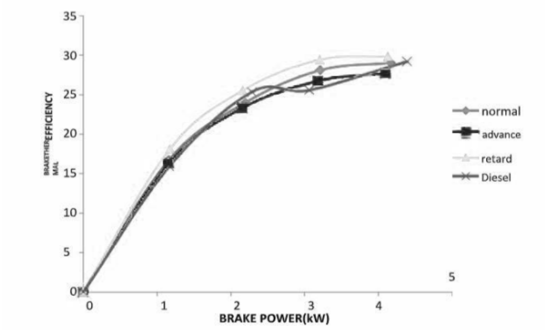

Figure 2: Variation of Brake Thermal Efficiency with Brake Power

Specific Fuel Consumption

Figure 3 shows the variation of BSFC with brake power the increasing in fuel concentration was responsible for raise in Brake specific fuel consumption for biodiesel blends. Raise in fuel injection pressure decrease the fuel injection duration, most significant to improved droplet diameter, which get better the air-fuel mixing, so rising more heat release rate, which results in major portion of heat significant at larger through the compression stroke, particularly for advancing fuel injection timing.

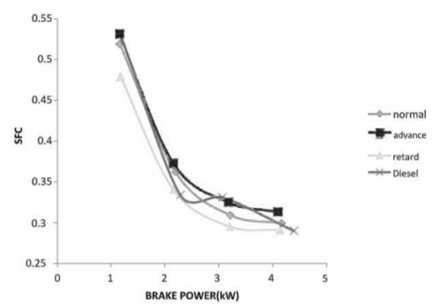

Figure 3: Variation of Specific Fuel Consumption with Brake Power

Pressure Rise VS Crank Angle

Variation of pressure rise with crank angle for full load is shown in Figure 4. The high value of pressure rise contributed to knocking, higher noise level and decreases the life of engine accordingly for any brake power. From the Figure 4, we can observe that even at higher loads biodiesel blends (KB20) have lower pressure rise than normal and advanced injection timing, which indicate that combustion of blends is smooth and it doesn't cause knocking which helps to improve engine life.

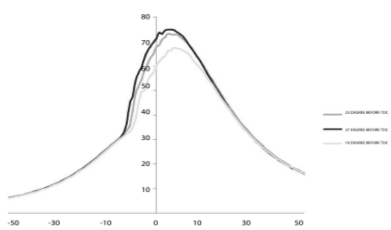

Figure 4: Variation of Pressure Rise with Crank Angle

Heat Release Rate VS Crank Angle

Figure 5, shows the comparison of net heat release rate for biodiesel blend at various loads and injection timings. The heat rate increases with an increase in brake power. Typically the diesel fuel has higher heat release rate than pure biodiesel and it blends, this is due the reason that blends have lower calorific value with raise in the engine load, earlier fuel mixing combustion phase is most important whereas at higher load the diffusion phase of combustion is more dominant. It is observed that retarding injection will give lower heat release rate at higher loads than running at normal and advance injection.

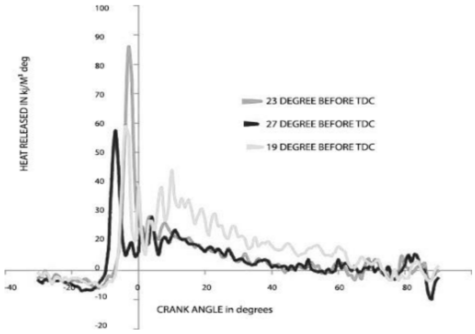

Figure 5: Variation of Heat Release Rate for Crank Angle

NO_x Emission

The variation of NOx emission was shown in Fig.6, NO_x emission of biodiesel blends (KB20) is higher than neat diesel at nearly all brake power. Probable reason would be the high cetane number of biodiesel blends. Generally, lower cetane number of fuels will have longer ignition delay and release more heat at the premixed phase of combustion. This causes higher combustion temperature and rapidly enhances the reaction between oxygen and nitrogen and subsequently yields more NO_x emission. The greatest NO_x emission for KB20 at 100% at 220 bar advanced SOI

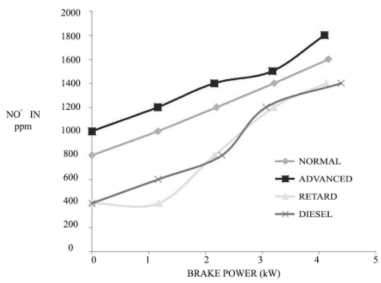

Figure 6: Variation of NO_x with Brake Power

CO Emission

Figure 7 shows the Variation of carbon mono-oxide emission with brake power for different injection timing. For different load conditions at 220 bar injection pressure, CO emissions were lowest at -19°CA SOI timing. In variance, they tend to widen the injection timing and significantly increase the smoke. Advanced SOI timings at -23°CA resulted in superior formation of fuel rich zones due to improved ignition delay and similarly lesser atomization of fuel injected throughout early start of fuel injection, after the heat and in-cylinder pressure moderately reduced. This show that this leads to higher combustion temperature and higher exhaust gas temperature and subsequently yield lower volumetric efficiency.

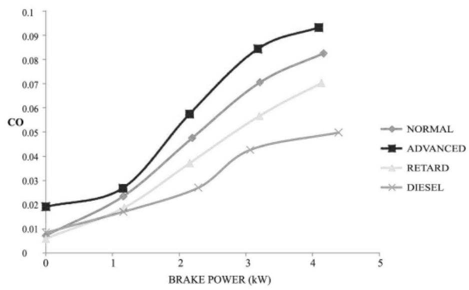

Figure 7: Variation of Ccarbon Mono Oxide with Brake Power

CONCLUSIONS

Optimisation of spray for different blends of bio-diesel by varying injection pressure with the concept of Taguchi and ANOVA with the help of “Minitab” software. In addition, KB20 at 220 bar injection is found to be the best optimum condition using Taguchi technique. It was found that bio-diesel blend (KB20) at 220 bar injection pressure and 19^0 bTDC injection timing will give better performance with lower pollutant emissions in Direct injection diesel engine.

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